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RODENT PESTS OF THE FARM

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Columbia Ground Squirrel B123M

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Contribution from the Bureau of Biological Survey
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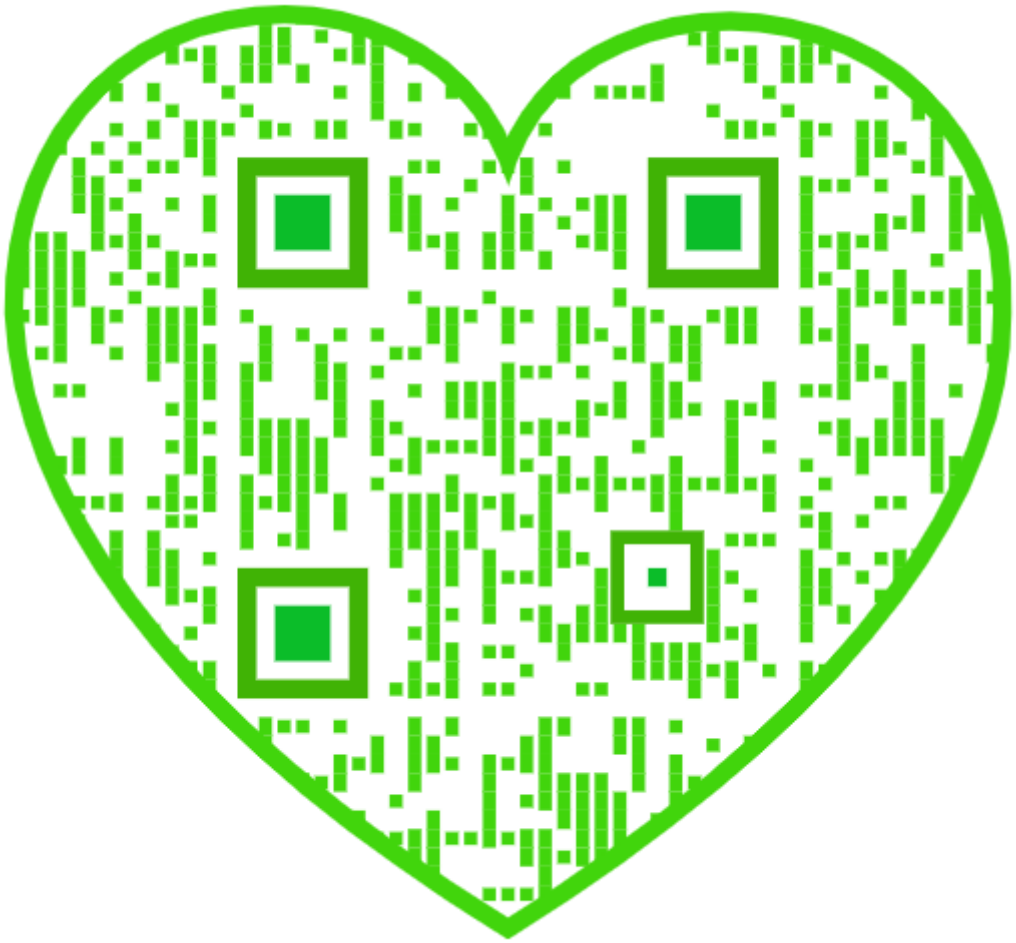

THE ANNUAL losses from rodent pests in the United States have been estimated as fully $300,000,000.

About two-thirds of the damage is inflicted by house rats and mice (both introduced from the Old World) and the remainder by native species.

This enormous waste of resources may be greatly reduced and largely prevented through systematic and organized campaigns against the noxious species.

The bounty system effects no permanent relief from rodents and is far more costly than the use of poisons.

The Bureau of Biological Survey has developed and perfected practical methods of extermination which have been successfully applied over wide territory.

The Bureau cooperates with the public in organizing and carrying out systematic campaigns against animal pests and invites correspondence on the subject.

Protection of their natural enemies is urged as an important aid in controlling rodent pests.

RODENT PESTS OF THE FARM.

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INTRODUCTORY.

RODENTS are among the most persistent and aggressive of the animal enemies of the tiller of the soil, and against them he is often more helpless even than against insect pests, because he has had less instruction as to their habits and the means of fighting them. To assist him by giving short accounts of the more important rodents that injure farm, ranch, and orchard, together with brief practical directions for destroying the pests, is the purpose of this bulletin.

The rodents of North and Middle America include about 77 distinct groups called genera, 44 of which have representatives north of Mexico. These 44 groups include about 750 forms that inhabit the United States and Canada. Many of them live in deserts, mountains, and swamps and rarely come in contact with cultivated crops. These, therefore, can not be classed as injurious; and, indeed, many of them are beneficial to the soil, as they stir it up and fit it for future agricultural uses. A few rodents feed largely upon insects and help to keep a check upon the hordes of grasshoppers and similar pests. Certain of the rodents, too, as the beaver and the muskrat, have a decided economic value as fur bearers; while some, as the rabbits and the tree squirrels, afford sport in hunting and are useful as human food.

The noxiousness of rodents depends largely upon the locality in which they live and upon their relation to man and his interests. All are chiefly vegetarian in diet and by reason of their rapid reproduction are capable of becoming pests; but it is only when they are actively injurious that means of control are needed.

Probably no term applied to animals has been so generally misused as the word "vermin." Originally restricted to small creeping animals, wormlike in their movements, and especially to insects, the term has been broadened by English gamekeepers to include all enemies of ground game. Usage now sometimes applies the term to all animals that are supposed to be either harmful or useless. Writers on game protection are often vehement in their condemnation of "vermin," forgetting that what may be so considered by one person may from the standpoint of another be highly useful. The interests of the sportsman or gamekeeper often run counter to those of his farmer neighbor, and they frequently clash on such matters as rabbit protection and the enforcement of trespass laws. A better understanding of the habits of birds and mammals, especially of their food and the interrelation of species that prey and are preyed upon, will greatly restrict the number of animals that may properly be called "vermin." Under natural conditions few can rightly be so designated; but man has interfered with nature until he has disturbed its balance. He has introduced artificial conditions and so changed the environments of animals that some have prospered while others have been driven out. The species that have been most favored by man's activities are, unfortunately, those that have been most harmful to his interests. As a result he must now make warfare upon foes that were once inoffensive.

HARMFUL NATIVE RODENTS.

Only four of the many forms of wild rodents found within the United States have been introduced; the others are indigenous to the country. Among harmful native rodents are included the short-tailed field mice, white-footed mice, cotton rats, kangaroo rats, pocket gophers, ground squirrels, prairie-dogs, woodchucks, and rabbits. A few others occasionally do slight damage to crops or other property.

SHORT-TAILED FIELD MICE.

Several groups, or genera, of short-tailed field mice occur in the United States and Canada, but only two of them have, by reason of their abundance in cultivated regions, become serious pests. These are commonly known as meadow mice [1] and pine mice [2] (fig. 1).

Meadow mice are widely distributed, inhabiting most parts of the Northern Hemisphere. In the United States we have many species, but, fortunately, have thus far had no widespread plagues of the animals like those that have occurred abroad. However, there have been many local outbreaks, notably that of 1907–8 in the Humboldt Valley, Nevada, where much of the alfalfa crop was utterly ruined. Fortunately, few of our species come in contact with farm operations,

[1] Genus *Microtus*. [2] Genus *Pitymys*.

but these few sometimes multiply enormously and inflict heavy damage by attacking and girdling fruit trees and by destroying other crops. Their presence is indicated by their many surface trails under dead grass, weeds, or other trash. The animals usually avoid open spaces, where they are exposed to such enemies as hawks and owls, birds which make these mice the chief part of their diet.

Depredations by meadow mice may be greatly lessened and serious outbreaks prevented by clean cultivation, the elimination of old fence rows, and the prompt burning of dead weeds and other trash.

Pine mice, like moles, burrow underground, where their tunnels are similar in extent and intricacy to the surface runways of meadow mice; but as their natural habitat is the woods, they come less frequently in contact with farm crops. Their most serious depredations

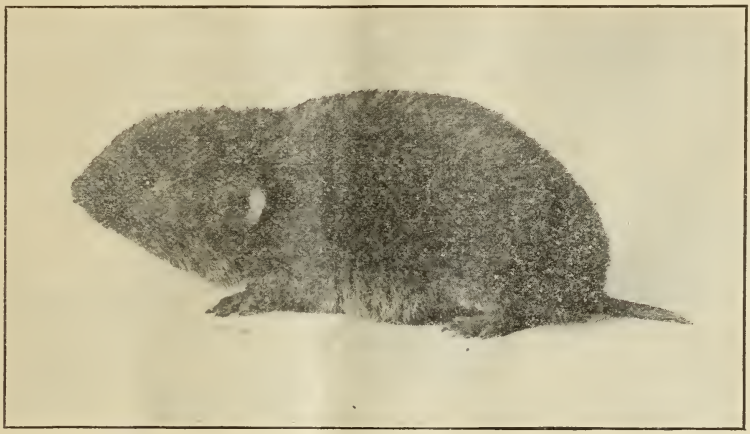


FIG. 1.—Pine mouse. B670M

are in orchards, although they often do great damage in lawns and plantations adjacent to woodlands by eating bulbs and gnawing the roots of shrubbery. In such situations they also frequently destroy potatoes, peanuts, and newly planted seeds of truck crops. Their concealed operations permit them to do much harm before their presence is suspected. For this reason, also, they are less often the victims of birds of prey.

Ordinary mouse traps of the guillotine type, baited with rolled oats and set in runways of either meadow or pine mice, will free a small area of the animals (fig. 2); but for large areas or for operations against considerable numbers of these mice, poisons are more effective.

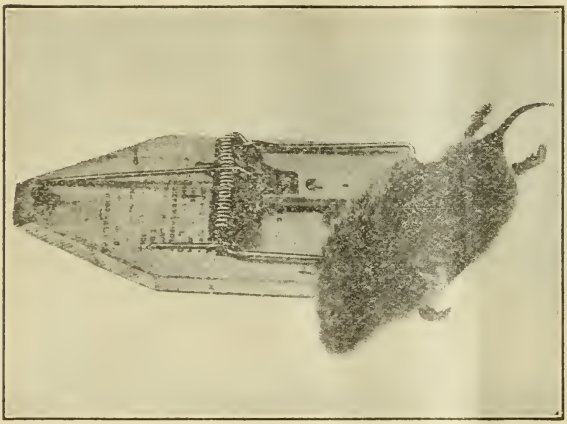
For poisoning meadow mice on large areas the following methods are recommended:

Dry-grain formula.—Mix thoroughly 1 ounce powdered strychnin (alkaloid), 1 ounce powdered bicarbonate of soda, and ½ ounce (or less) of saccharin.

Put the mixture in a tin pepperbox and sift it gradually over 50 pounds of crushed wheat, or 40 pounds of crushed oats, in a metal tub, mixing the grain constantly so that the poison will be evenly distributed. Dry mixing has the advantage that the grain may be kept any length of time without fermentation. If it is desired to moisten the grain to facilitate thorough mixing, it will be well to use a thin starch paste (as described below, but without strychnin) before applying the poison. The starch soon hardens, and fermentation is not likely to follow.

If crushed oats or wheat can not be obtained, whole oats may be used, but they should be of good quality. As mice hull the oats before eating them, it is desirable to have the poison penetrate the kernels. A very thin starch paste is recommended as a medium for applying poison to the grain. Prepare as follows:

Wet-grain formula.—Dissolve 1 ounce of strychnin (sulphate) in 2 quarts of boiling water. Dissolve 2 tablespoonfuls of laundry starch in ½ pint of cold water. Add the starch to the strychnin solution and boil for a few minutes until the starch is clear. Pour the hot starch over 1 bushel of oats in a metal tub and stir thoroughly. Let the grain stand overnight to absorb the poison.



B58M

FIG. 2.—Meadow mouse caught in guillotine trap.

The poisoned grain prepared by either of the above formulas is to be distributed over the infested area, not more than a teaspoonful at a place, care being taken to put it in mouse runs and at the entrances to burrows. To avoid destroying birds it should whenever possible be placed under such shelters as piles of weeds, straw, brush, or other litter, or under boards. Small drain tiles 1½ inches in diameter have sometimes been used to advantage to hold poisoned grain, and old tin cans with the edges bent nearly together will serve the same purpose.

Chopped alfalfa hay poisoned with strychnin was successfully used to destroy meadow mice in Nevada during the serious outbreak of the animals in 1907–8:

Alfalfa formula.—One ounce of strychnin (sulphate) dissolved in 2 gallons of hot water was found sufficient to poison 30 pounds of chopped alfalfa previously moistened with water.

This bait, distributed in small quantities at a place, was very effective against the mice and did not endanger birds.

For poisoning mice in small areas, as lawns, gardens, seed beds, vegetable pits, and the like, a convenient bait may be prepared from ordinary rolled oats, as follows:

Oatmeal formula.—Dissolve $\frac{1}{16}$ ounce of strychnin in 1 pint of boiling water and pour it over as much oatmeal (about 2 pounds) as it will wet. Mix until all the grain is moistened. Put it out, a teaspoonful at a place, under shelter of weed and brush piles or wide boards.

The poisoned oatmeal is adapted for killing either meadow or pine mice, but for the latter sweet potatoes, prepared as follows, have proved even more effective:

Potato formula.—Cut sweet potatoes into pieces about the size of grapes. Place 3 quarts of these cut baits in a pan or bucket, and from a tin pepperbox slowly sift over them $\frac{1}{8}$ ounce of powdered strychnin mixed with an equal quantity of baking soda, stirring constantly so that the poison is evenly distributed. Poison should be applied as soon as potatoes are cut and bait should be put out while fresh.

The bait, whether of grain or pieces of potato, may be dropped into the pine mouse tunnels through the natural openings or through holes made with pieces of broom handle or other stick. Bird life will not be endangered by baits thus placed.

WHITE-FOOTED MICE.

White-footed mice, or deer mice,[1] are of many species and are present in almost all parts of the country. They live in fields and woods, and while they feed on grain to some extent, they rarely are present on cultivated lands in sufficient numbers to do serious harm. Occasionally they invade greenhouses or hotbeds and destroy seeds or sprouting plants. In the seed beds of nurserymen, and especially in those of the forester who tries to grow conifers, they often do much injury. They are, in fact, the most serious pests known to the conifer nurseries of the Forest Service.

In ordinary places white-footed mice may be readily poisoned by the methods recommended for meadow and pine mice. Unfortunately the seed of the pine is the favorite food of these animals and where it is planted in abundance they refuse to take grain baits. Crushed pine seeds poisoned with strychnin by the "wet-grain formula," given above, have proved effective in such places. Preliminary poisoning of these mice on areas to be seeded to pine is highly recommended. For seed beds, poisoning on surrounding areas two or three times a year will usually prevent the approach of mice and give immunity to the planted seeds.

COTTON RATS.

In parts of the Southern States a large native mouse, or rat, commonly known as the cotton rat[2] (fig. 3), often becomes a field pest.

[1] Genus *Perompscus*. [2] Genus *Sigmodon*.

Of some 28 known forms of this animal, 7 occur north of Mexico, in Texas, New Mexico, Arizona, Oklahoma, and southern Kansas and along the Gulf coast from Louisiana to Florida.

Cotton rats damage growing crops to some extent, but are especially destructive to grain in shocks. In many of their habits they are similar to meadow mice, and they multiply fully as fast. They chiefly inhabit weedy borders and areas covered with old grass, where they are sheltered from enemies. They do not often attack the bark of trees, but, being larger than meadow mice, are capable of destroying much more grain in a short time. They ruin melons and other truck crops and have been a serious pest to date growers in Arizona.

Cotton rats are easily poisoned by the same methods recommended for destroying meadow mice.

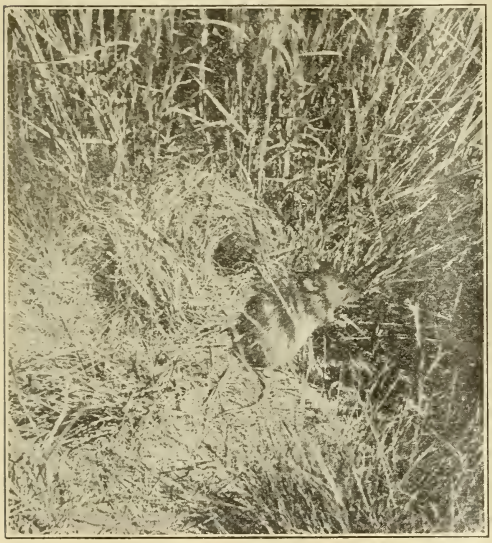


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FIG. 3.—Cotton rat (dead) and nest, Pecos Valley, Tex.

KANGAROO RATS.

Fifty-nine known species and races of the kangaroo rat (fig. 4), belonging to three groups, inhabit North America, and 45 of them occur north of Mexico. Two groups[1] are widely distributed in the West; they differ in anatomical characters, but are much alike in general appearance and habits. A third group[2] includes three species and one race of very small animals, all of which are rather restricted in range and of slight economic importance. Kangaroo rats are gentle, easily tamed, and make sprightly and interesting pets. They live mostly in deserts, sagebrush country, and sandy places and are harmless until pioneer agriculture is pushed into these regions. They feed to some extent on green vegetation, but mainly on seeds. As they do not hibernate, they lay up large stores of winter food in their burrows. They are gregarious but, being noctural in their activities, are seldom seen by day.

In the sand-hill and sagebrush country of the West there is much complaint of destruction of pioneer crops by kangaroo rats. The areas first cultivated are usually small, and the animals sometimes destroy an entire crop. Where corn is planted they take all the seed, securing not only food for present use, but storing in their caches large

[1] *Perodipus* and *Dipodomys*.

[2] Genus *Microdipodops*.

quantities for the future. They are destructive to other grains also and dig up newly planted melon and other seeds. Vegetable gardening is an impossibility where kangaroo rats are abundant. The choice is between making warfare on and destroying the animals or abandoning cultivation. Fortunately they take poisoned grain readily and are easily trapped with baits of this kind. The poison recommended for prairie-dogs is well adapted to destroy kangaroo rats. Trapping with guillotine traps, although successful, is usually too slow to be practicable.

In some instances farmers in the sand-hills of the West prevent depredations by kangaroo rats and succeed in growing crops of corn by stirring the seed in hot water in which there has been mixed enough coal tar to coat the grain slightly. A large spoonful of coal

FIG. 4.—Kangaroo rat, adult, one day after capture. B252M

tar to a gallon of boiling water is used. When the mixture has cooled somewhat the corn may be stirred in and allowed to remain several minutes without danger to germination.

POCKET GOPHERS.

Pouched rats, commonly called pocket gophers (fig. 5), are among the most serious of rodent pests in most of the States west of the Mississippi River. They occur also in parts of Georgia, Alabama, and Florida, in the greater part of Illinois, and in southern Wisconsin. Outside the United States they are abundant southward in many parts of Mexico and Central America, and northward in northwestern Canada to Winnipeg and the Saskatchewan Valley.

Nine groups, or genera, of pocket gophers are recognized, but only three of them occur north of Mexico. Two of these[1] have a very

[1] *Geomys* and *Thomomys*.

wide distribution. They include many species and varieties, all nearly similar in habits and alike destructive. Many forms inhabit mountains and deserts, where they do not injure agriculture. Others, however, live in the richest alluvial soils, where they are destructive to all crops.

Pocket gophers do harm in many ways. They eat growing grain and cover much of it with soil. In digging burrows they cause loss of hay by throwing up mounds which prevent close mowing. These mounds also injure much machinery. Their burrows admit surface water and aid it to wash out deep gullies on sloping land. By piercing dams and embankments the tunnels cause costly breaks. The animals ruin gardens and injure field crops. In addition to this they kill trees in orchards and in forest plantings by gnawing off the roots.

FIG. 5.—Pocket gopher. B999M

Two practical methods of killing pocket gophers are always possible—trapping and poisoning. The first method is slow, but very effective on small areas or where but few pocket gophers are present; the other is the better plan on large fields and for cooperative work on adjacent farms. While the ordinary steel trap may be used successfully for pocket gophers, much better results can be obtained with the special traps for these animals commonly on the market (fig. 6).

In irrigated districts, where water is available, flooding the land will drive out the animals, and they may be killed by men and dogs. Fumigation of the burrows with carbon bisulphid or with sulphur smoke, while often recommended as a means of destroying pocket gophers, has been found extremely uncertain and costly.

Poison for pocket gophers.—Cut sweet potatoes or parsnips into pieces with the largest diameter less than an inch. Wash and drain 4 quarts of the cut baits. Place in a metal pan, and from a pepperbox slowly sift over the dampened baits ½ ounce of powdered strychnin (alkaloid) and one-tenth as much saccharin (well shaken together or ground together in a mortar), stirring to distribute the poison evenly.

Tunnels of pocket gophers, which are usually from 3 to 8 inches below the surface of the ground, may be readily located by means of a probe. Any blacksmith can make one by affixing a metal point

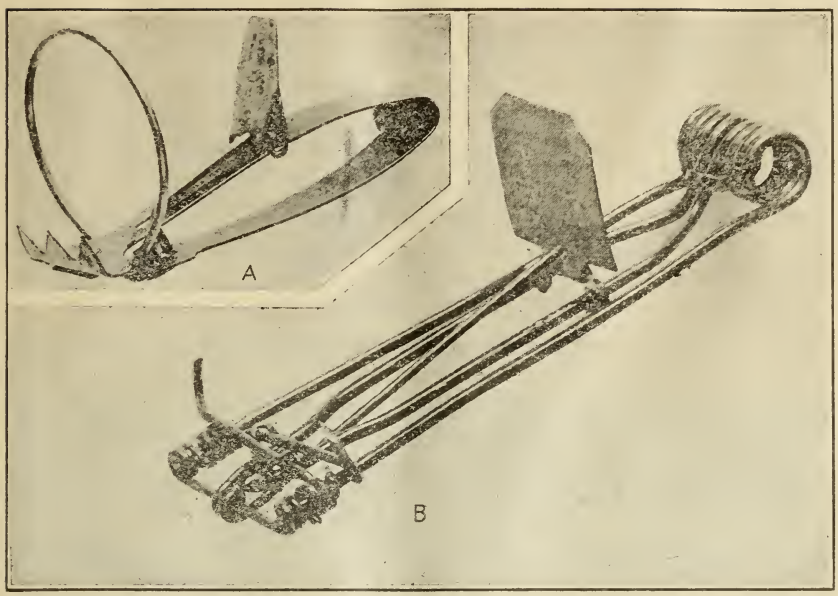


FIG. 6.—Types of special pocket-gopher traps. B611M

to a shovel or spade handle and attaching an iron foot rest about 15 or 16 inches above the point. By forcing this instrument into the soil near the pocket-gopher workings, or a foot or two back of fresh mounds, one can feel the open tunnel as the point breaks into it. The hole may be enlarged and its sides made firm by pressing the soil laterally with the probe. A bait or two should be dropped into the tunnel and the probe hole covered. Care should be taken to place the baits in the main tunnels rather than in the short laterals leading to mounds. Different forms of probes have been used successfully by the Biological Survey in its demonstration work. Two of the better kinds are illustrated in figure 7.

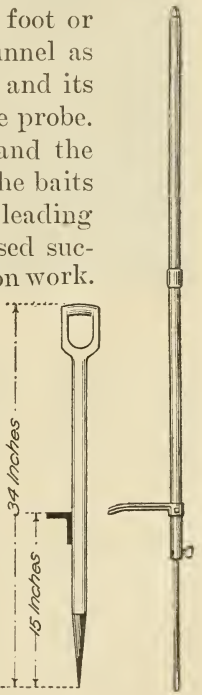


FIG. 7.—Convenient probes for locating pocket-gopher runs.

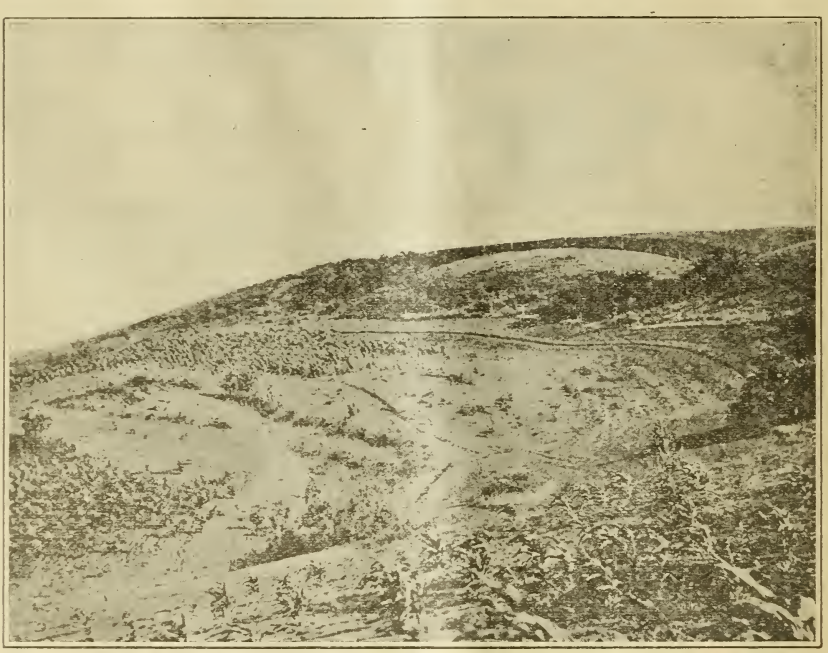
GROUND SQUIRRELS.

More than 50 species and races of ground squirrels, or spermophiles,[1] inhabit the United States and Canada, and some of them are so numerous in agricultural regions as to be a constant menace to the crops. The spermophiles comprise a group of long, slender animals, of grayish or grayish-brown color—sometimes mottled or striped—and with a medium or long tail, usually less bushy than that of the larger of the tree squirrels. These ground squirrels are often, but wrongly, called "gophers" and are locally named "dig-

[1] Genus *Citellus*.

ger" squirrels and "picket pins." They inhabit mainly open plains, mountain valleys, and borders of wet meadows, but are found also in open places in the forests and sometimes high up the slopes of mountains. They dig numerous deep burrows and are very destructive to nearly all crops (figs. 8 and 9), eating both the growing plants and the ripe or ripening grain. In irrigated districts the animals burrow in embankments (fig. 10) and levees and are almost as troublesome as pocket gophers.

Among the largest and most destructive of these animals is the California, or "digger," ground squirrel.[1] It is gray in color and



B9141

FIG. 8.—Cornfield ruined by Columbia ground squirrels (see title-page illustration).

has a long, rather bushy tail. It occurs in the Southwest and West from western Texas to California and Oregon.[2] In parts of California the race known as the Beechey ground squirrel is especially abundant and menaces not only crops and irrigation ditches, but also human life, in that it is a known carrier of bubonic plague. About a dozen cases of this disease among human beings have been traced directly to this squirrel and a large number of the animals collected by the United States Public Health Service have been found infected. The Health Service, in cooperation with State authorities, has succeeded in establishing south and east of San Francisco, in the

[1] *Citellus beecheyi beecheyi* and related races.

[2] Including the closely related *Citellus grammurus*.

counties that were the center of infection, a wide zone now comparatively free from squirrels. The Department of Agriculture, through the Bureau of Biological Survey, has exterminated most of the squirrels in the national forests that lie near the plague-infected counties. It is probable that all immediate danger of an outbreak of human plague by infection from ground squirrels has passed.

Another large and destructive species is the Columbia ground squirrel[1] (see illustration on title-page). It occurs within the United States in parts of Montana, Idaho, eastern Washington, and eastern Oregon. While it inhabits chiefly the river valleys, it has been taken in Montana on mountains near timberline. Where grain is grown

FIG. 9.—Mound of California ground squirrel in oats field. B11132

in the narrow valleys and in the important wheat districts of eastern Washington this species is extremely injurious. Early attempts to destroy it by poison proved unsuccessful, because the animal is able to resist much larger doses of strychnin than are needed to kill other ground squirrels.

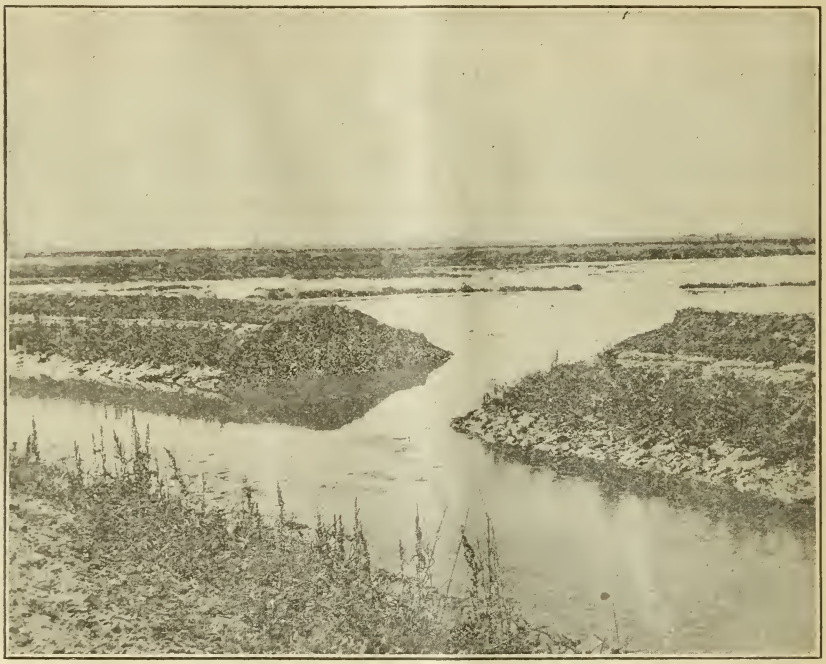
A destructive and widely distributed species is the Richardson ground squirrel.[2] In its larger form it is found in much of Montana, the Dakotas, and northward into Canada. A somewhat smaller race (*elegans*) is found in southeastern Oregon, northern Nevada, southern and eastern Idaho, southern Wyoming, and northern Colorado. This spermophile is very destructive to crops, especially to

[1] *Citellus columbianus.*

[2] *Citellus richardsoni richardsoni* and *Citellus richardsoni elegans.*

grain, and within its range warfare against it is absolutely necessary to successful farming.

The striped ground squirrel,[1] the Franklin ground squirrel,[2] and some other species, which are less gregarious and seldom occur in great numbers in any locality, are less destructive than any of the three groups named. Other species are nearly as injurious as those described. The animals have been dealt with in three groups, because slightly different formulas for poisoning each of them have been worked out by field investigators of the Biological Survey. The



B11148

FIG. 10.—Break in irrigation ditch (lateral) caused by burrowing of California ground squirrel. Six acres of alfalfa ruined.

formula for the Richardson ground squirrel is adapted for all the species except the Columbia and the California forms.

Poison for Columbia ground squirrels.—Mix 1 ounce of powdered strychnin (alkaloid), 1 ounce of powdered bicarbonate of soda, 1 teaspoonful of saccharin, and ½ pound of dry powdered laundry starch, and stir with enough cold water to make a smooth, creamy paste. Apply to 12 quarts of good, clean oats in a metal tub or other vessel, and stir thoroughly to distribute the poison evenly. When the poisoned grain is dry scatter it along squirrel trails or on hard soil on the surface near the squirrel burrows. A quart of the grain should make 40 to 50 baits, and if properly distributed stock will not be endangered by this quantity.

[1] *Citellus tridecemlineatus,* including several races.
[2] *Citellus franklini.*

Poison for Richardson ground squirrels.—Mix 1 tablespoonful of laundry starch in ½ teacup of cold water, and stir it into ½ pint of boiling water to make it a thin, clear mucilage. Mix 1 ounce of powdered strychnin with 1 ounce of powdered bicarbonate of soda, and stir the mixture into the hot starch, making a smooth, creamy paste free from lumps. Stir in ¼ pint of heavy corn sirup and 1 tablespoonful of glycerin, and, finally, 1 scant teaspoonful of saccharin. Apply to 20 quarts of oats, and mix thoroughly to coat every kernel. Each quart of the poisoned grain should make 40 to 60 baits. Distribute in same manner as stated for poisoning Columbia ground squirrels.

Poison for California, or "digger," ground squirrels.—Prepare by same formula as for Richardson ground squirrels, but use 16 quarts of clean barley instead of oats. Distribute as for poisoning Columbia ground squirrels.

These poisons may be used at any time of the year when the squirrels are active. The Biological Survey has had excellent results with them, even in midsummer. Trapping is too slow a process to use effectively against large colonies of ground squirrels.

B 14282

FIG. 11.—Prairie-dog.

PRAIRIE-DOGS.

The prairie-dog[1] (fig. 11) of the Great Plains needs little description. It is widely distributed on the plains east of the Rocky Mountains, from northern Mexico almost to the Canadian border. Several other forms occupy the mountain valleys and parks westward. All live in thickly populated colonies, or "towns," and subsist on vegetation. They often take fully half the pasturage on the ranges and greatly reduce the carrying capacity for live stock (fig. 12). Several Western States have attempted to provide for the extermination of prairie-dogs through legislative enactments; and in some of them, notably Kansas, the pest has greatly decreased. Within the national forests settlers have complained of inability to cope with the animals, because their lands when freed from prairie-dogs are reinfested from the surrounding Government lands. For this reason and for range improvement the Department of Agriculture has undertaken systematic extermination work within the forests and has already succeeded in freeing large areas of these animals.

[1] *Cynomys ludovicianus.*

Trapping is too slow a method for exterminating prairie-dogs, and fumigation is too expensive. As in the case of ground squirrels, strychnin has proved to be the most satisfactory poison. Oats of the best quality obtainable should be used as bait. It has been found that prairie-dogs take this grain readily, even when green food is abundant. Wheat is well adapted for winter poisoning, and in the South, where heavy oats are rarely obtainable, milo or feterita is an excellent substitute.

Poison for prairie-dogs.—Mix thoroughly 1 ounce of powdered strychnin (alkaloid) and 1 ounce of common baking soda (bicarbonate). Dissolve 1 heaping tablespoonful of dry laundry starch in a little cold water and add it

B14233

FIG. 12.—Erosion following the destruction of grass by prairie-dogs.

to ¾ pint of boiling water. Boil and stir until a thin, clear paste is formed. Slowly sift the mixture of strychnin and soda into the starch paste, stirring constantly to form a smooth, creamy mass. Add ¼ pint of heavy corn sirup and 1 tablespoonful of glycerin, and stir. Add $\frac{1}{10}$ ounce of saccharin, and again stir thoroughly. Pour this mixture while still hot over 13 quarts of clean oats and mix until all the grain is coated.

If alkaloid strychnin is not available, the sulphate may be used, either powdered or in crystals, but it is necessary to vary the formula. Dissolve the strychnin in the boiling water before adding the cold starch. After the poisoned starch paste is clear, stir in the soda very slowly. Then add the sirup, glycerin, and saccharin as in the above directions and mix with the grain.

For mixing small quantities an ordinary metal washtub is convenient. For large quantities a tight, smooth box may be used, and the mixing done with a hoe or spade.

Each quart of the prepared grain is sufficient to treat about 50 prairie-dog burrows. Scatter the grain on clear, hard ground near the mounds or burrows, never on loose soil or in the holes. With reasonable care, cattle, sheep, or other live stock on the range will not be endangered.

This poison is effective at any season when prairie-dogs are active, but, on the whole, early spring or a time of drought, when green food is scarce, is preferred for poisoning operations. In the South, or wherever the animals do not hibernate, winter poisoning is recommended. The cost of complete extermination of the animals, including labor, need not exceed 4 or 5 cents an acre.

B 18056

FIG. 13.—Woodchuck, known also as marmot and ground-hog.

WOODCHUCKS.

The woodchuck, or ground-hog, is the largest of our marmots. The common woodchuck (fig. 13)[1] inhabits eastern North America from northern Georgia and middle Alabama northward, including the greater part of Canada. In the United States it ranges westward to Arkansas, eastern Kansas, and eastern Minnesota. In Canada it is found as far north as Great Slave Lake and westward to the base of the Rocky Mountains. Another species of woodchuck[2] inhabits the higher country of the Black Hills, Rocky Mountains, Sierra Nevada, Cascades, and other ranges in the West. This mountain form seldom comes in contact with agriculture, but the eastern species frequently damages garden vegetables, clover, and other crops. Also, its burrows and mounds interfere with mowing and other farm operations. In some States the animal is regarded as so obnoxious that local bounties are paid for destroying it.

Woodchucks, while somewhat gregarious, seldom occur in large colonies, and may, therefore, be kept in check by shooting or trapping. They may be poisoned by strychnin inserted in pieces of sweet apple, carrot, or sweet potato. The animals are often destroyed in

[1] *Marmota monax monax* and several geographic races.

[2] *Marmota flaviventris flaviventris* and nearly a dozen races.

their burrows by fumigation with carbon bisulphid or by the discharge of blasting powder.

To destroy woodchucks with carbon bisulphid, saturate a wad of cotton or waste with about 1½ ounces of the liquid. Place the cotton well inside the woodchuck burrow and close the opening with a piece of sod, well stamped down. If there are two or more entrances to a burrow, all but one should be tightly closed before fumigation.

RABBITS.

The smaller forms of rabbits, known generally as cottontails,[1] are useful animals and become objectionable only when too numerous in

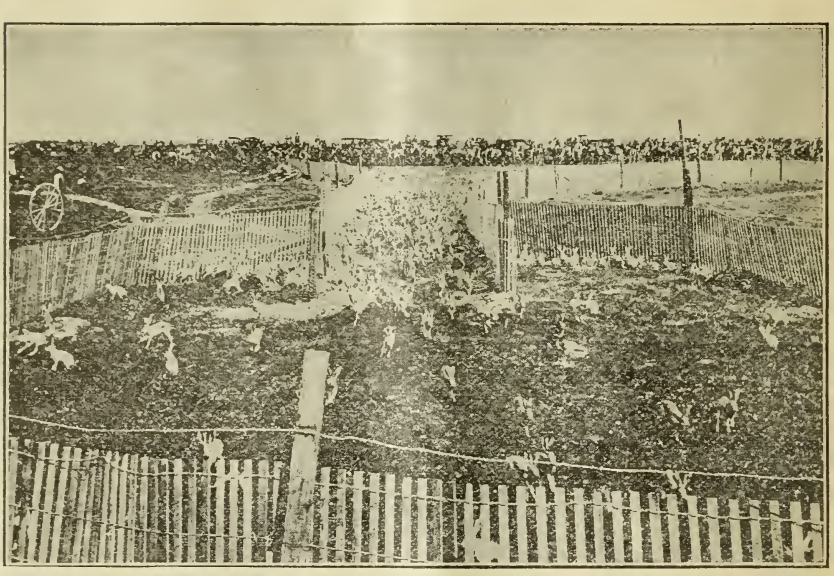


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FIG. 14.—An organized rabbit drive. Community cooperation in hunting jack rabbits gives very good results in rendering the numbers of these animals, everywhere regarded as a pest.

the vicinity of orchards or nurseries. The same is true of the larger snowshoe rabbits.[2] The jack rabbits[2] of the West are of less value for human food, and, by reason of their abundance in newly settled regions, often interfere greatly with crops and the growing of orchard and other trees.

Jack rabbits are not protected in any of the States, but are everywhere regarded as a pest. They afford considerable sport in coursing with fleet greyhounds, and at times become so abundant and destructive that entire communities unite to kill them by the organized hunt or drive (fig. 14). A large area is surrounded, and the animals are driven toward some central point, where a wire corral

[1] Genus *Sylvilagus*. [2] Genus *Lepus*.

has been built, into which, with the help of wing barriers, thousands of rabbits are driven and then slaughtered. When these hunts take place in cold weather the rabbits are usually shipped to large cities, where the carcasses may be sold to canning establishments, distributed to public charities, or otherwise used to supplement the meat supply.

Many of the States which have a close season for cottontail or other native rabbits permit landowners at any time to protect property from the depredations of the animals. Usually, however, close hunting and trapping in the open season afford ample protection, and only in exceptional cases is it necessary to resort to other measures for relief.

Except where deep snows fall, orchards or other crops on small areas may be protected by the use of rabbit-proof fencing. Individual trees may be safeguarded by metal or wooden protectors attached to the trunks. In Idaho a poisoned wash of strychnin, glycerin, and starch proved effective to save trees from jack rabbits, and the method is recommended for trial in any locality where conditions warrant its use. The wash is prepared as follows:

Poison wash.—Dissolve 1 ounce of strychnin (sulphate) in 3 quarts of boiling water. Dissolve ½ pound of laundry starch in 1 pint of cold water, stirring thoroughly. Pour the starch into the vessel containing the strychnin and boil the mixture a short time until the starch is clear. Add 6 ounces of glycerin and stir. When the paste is cool enough apply to tree trunks with a paint brush.

The mixture adheres well and forms a thin coating. If rabbits attack the tree they will be killed before they can seriously injure it. The wash should not be used if live stock, especially young cattle, have access to the orchard.

For poisoning jack rabbits in winter the following formula is recommended:

Poison baits.—Good oats, 12 quarts; powdered strychnin, 1 ounce; laundry starch, 1 tablespoonful; soda (bicarbonate), 1 ounce; saccharin, ⅛ ounce; water, 1 quart. Prepare as directed for mixing prairie-dog poison. Not over a tablespoonful of the poisoned grain should be used in a single bait, and this should be scattered considerably. A little alfalfa hay may be used to attract rabbits to the grain. The poison is especially effective when snow covers the ground.

Partly ripened or ripe heads of barley or wheat soaked in a sweetened solution of strychnin or coated with the starch-strychnin paste just described have also proved effective bait for rabbits, but care must be exercised in using them, as they are likely to be eaten by live stock.

OTHER NATIVE RODENTS.

Other native rodents that occasionally damage crops or other property are the muskrat, mountain-beaver (fig. 15),[1] woodrats,[2] tree

[1] Genus *Aplodontia.* [2] Genus *Neotoma.*

squirrels, chipmunks, and perhaps some species of native mice not already mentioned. Muskrats are valuable fur animals and should not be destroyed unless they are doing material damage not otherwise preventable. They are easily trapped or may be poisoned by feeding them pieces of carrot, sweet apple, or sweet potato in which strychnin has been placed.

Mountain-beavers in the United States are restricted to the coastal region of Washington, Oregon, and California, and to the Sierra Nevada in the last-named State. Their habitat does not often bring them in contact with agriculture, but in western Washington considerable complaint of their depredations on crops, particularly small fruits, has been made. The animals may be readily poisoned with apples in which strychnin has been placed.

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FIG. 15.—Mountain-beaver, or sewellel, a pest in parts of the Northwest.

Squirrels, chipmunks, and native mice not previously mentioned rarely do serious damage. If any become troublesome locally, shooting, trapping, or the use of poisons herein recommended for other rodents will prove satisfactory means of relief.

INTRODUCED RODENTS.

The house mouse and three kinds of rats are the only rodent pests in North America not native to the country. They are our most injurious rodents, however, and probably inflict greater losses than do all the native species combined.[1]

House mice are easily trapped or poisoned, but poison is not suited for use in occupied dwellings. Traps, however, are sufficiently effective for clearing the premises of these pests. The ordinary small guillotine traps are recommended. They should be set as lightly as possible and baited with oatmeal (rolled oats). A few grains should be placed on the trigger pan and a little more in the vicinity and close to the trap. Persistent trapping will soon clear an ordinary dwelling of mice.

[1] For a full discussion of these rodents, see Farmers' Bulletin 896, "House Rats and Mice," 1917.

Rats are much more suspicious than mice and are rather hard to trap or poison. Either method of destroying them may be made effective by making inaccessible all food other than the baits used. The importance of rat-proofing buildings in extensive operations against these pests should not be overlooked; and much loss may be prevented by rat-proofing all containers of stored grains and food products. No one kind of poison can be relied upon to be effective under every circumstance. In general, poisons can not be used in occupied dwellings without disagreeable results, for no poison will prevent decomposition of dead bodies of rats. Inside of residences, therefore, traps must be the main reliance. Simple traps of the guillotine type are recommended as best. Baits should be varied to suit local conditions—in meat markets grains are recommended, and where grain is stored meat and fish are more effective.

Some cats and some dogs are useful against rats, but the well-fed and pampered feline or canine will refuse to hunt them. Ferrets are of no use in rat catching unless handled by an experienced person helped by trained dogs. Rat viruses seldom prove satisfactory, and in occupied premises are open to the same objections that hold against poisons; besides, they are much more expensive.

Under most circumstances the best results in ridding premises of rats may be obtained by the use of a sufficient number of ordinary guillotine traps. Oatmeal is recommended for bait, but fish, bacon, sausage, and even pastry or cheese are sometimes useful as alternatives. Traps should be set lightly, and all food other than baits should be covered or made inaccessible. Traps may be placed in runs, behind furniture or boards leaned against the walls, or at the entrances to rat holes. As they are often sprung when rats run over them, they need not always be baited. It is needless to say that in order to succeed, the trapper must take an interest in his work and attend closely to every detail.

RELATION OF CARNIVOROUS ANIMALS TO RODENTS.

Most carnivorous, or flesh-eating, animals feed extensively on the rodent pests of the farm. Coyotes, foxes, wildcats, badgers, skunks, minks, and other flesh-eating mammals are among the most potent agents in preventing an undue increase of mice, ground squirrels, pocket gophers, and the like; and much of the damage now done by rodents is due to the unceasing warfare that has been waged against their enemies, the carnivorous animals. These have been hunted, not only for their valuable pelts, but because they are considered the enemies of domestic animals and game. The fact that many of them destroy far more noxious rodents than they do useful animals has often been forgotten, and, in the name of game protection, legislatures have sometimes proscribed by bounties species that do far more

good than harm. As a matter of fact many of our fur animals are an asset to the country, equally as valuable as our game, and experience has often proved that their destruction is no real help to game conservation.

Birds of prey, including eagles, hawks, and owls, may be included in the list of flesh-eating animals that on the whole are more useful than harmful, because their chief economic function is to destroy noxious rodents. A few species of hawks that feed mainly on small birds should be considered noxious, but this should not lead to warfare against hawks as a class. In almost every instance of depredation on poultry by either bird or mammal, the individual and not the species is the offender. Punishment should, therefore, be directed against the individual. It is within the law in many States for the farmer to kill an animal that destroys his property; but it is unjust to carry on an offensive campaign against all hawks or all minks because one has been a marauder on poultry. The payment of money from the public treasury in a general warfare against certain hawks or owls is especially open to danger, in that the public does not distinguish between species, and the useful ones are often the ones to be destroyed.

Snakes also are extremely useful in controlling the numbers of rodents. That very few snakes are venomous is too often forgotten, and all species are wantonly destroyed. People throughout the country should acquaint themselves with the habits of snakes and learn the folly of killing them; farmers, especially, should do all in their power to protect the harmless kinds.

COOPERATION IN CONTROLLING RODENTS.

Any farmer may by care and industry free his own premises of harmful rodents, but he is helpless to prevent an early recurrence of the trouble unless he can secure the active cooperation of his neighbors.[1] Only by unity of effort can an entire county or township be freed of any kind of rodent that may inflict losses on crops or other property. By combining to hire labor and purchase poison the cost of treatment may be materially reduced, and when permanance of results is considered there can be no question of the economy of such cooperation. It is urged, therefore, that wherever possible the destruction of rodent pests be made a community undertaking.

In the past, individual efforts, often supplemented by the payment of bounties by State, county, or township, have accomplished so little to reduce rodent depredations that other methods are now required. In many western counties the sum paid out in a single year

[1] Cf. Separate No. 724, from the Yearbook of the Department of Agriculture for 1917, entitled "Cooperative Campaigns for the Control of Ground Squirrels, Prairie-Dogs, and Jack Rabbits," by W. B. Bell.

for bounties on pocket gophers or ground squirrels would, if wisely expended in poisoning operations, secure the destruction of every such animal in the county and make unnecessary any further outlay for the purpose. The bounty system affords no permanent relief from rodent pests and entails heavy taxation as long as it is continued.

The Bureau of Biological Survey has developed effective methods of destroying field mice, pocket gophers, ground squirrels, prairie-dogs, and other noxious rodents. These have been applied over wide areas and their effectiveness fully demonstrated. The work has been done on public lands by the bureau alone or elsewhere in cooperation with other bureaus or with State or county authorities. A wide extension of these activities is planned, and correspondence or conference on the subject is invited.

PUBLICATIONS OF THE U. S. DEPARTMENT OF AGRICULTURE RELATING TO NOXIOUS MAMMALS.

AVAILABLE FOR FREE DISTRIBUTION.

How to Destroy Rats. (Farmers' Bulletin 369.)
The Common Mole of Eastern United States. (Farmers' Bulletin 583.)
Field Mice as Farm and Orchard Pests. (Farmers' Bulletin 670.)
Cottontail Rabbits in Relation to Trees and Farm Crops. (Farmers' Bulletin 702.)
Trapping Moles and Utilizing Their Skins. (Farmers' Bulletin 832.)
House Rats and Mice. (Farmers' Bulletin 896.)
Cooperative Campaigns for the Control of Ground Squirrels, Prairie-Dogs, and Jack Rabbits. (Separate 724, Yearbook for 1917.)
The House Rat: The Most Destructive Animal in the World. (Separate 725, Yearbook for 1917.)

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C.

Some Common Mammals of Western Montana in Relation to Agriculture and Spotted Fever. (Farmers' Bulletin 484.) Price 5 cents.
Meadow Mice in Relation to Agriculture and Horticulture. (Separate 388, Yearbook 1905.) Price 5 cents.
Pocket Gophers as Enemies of Trees. (Separate 506, Yearbook 1909.) Price 5 cents.
The Jack Rabbits of the United States. (Biological Survey Bulletin 8.) Price 10 cents.
Coyotes in Their Economic Relations. (Biological Survey Bulletin 20.) Price 5 cents.
Economic Study of Field Mice, Genus *Microtus*. (Biological Survey Bulletin 31.) Price 15 cents.
Directions for the Destruction of Wolves and Coyotes. (Biological Survey Circular 55.) Price 5 cents.
Destruction of Deer by the Northern Timber Wolf. (Biological Survey Circular 58.) Price 5 cents.

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